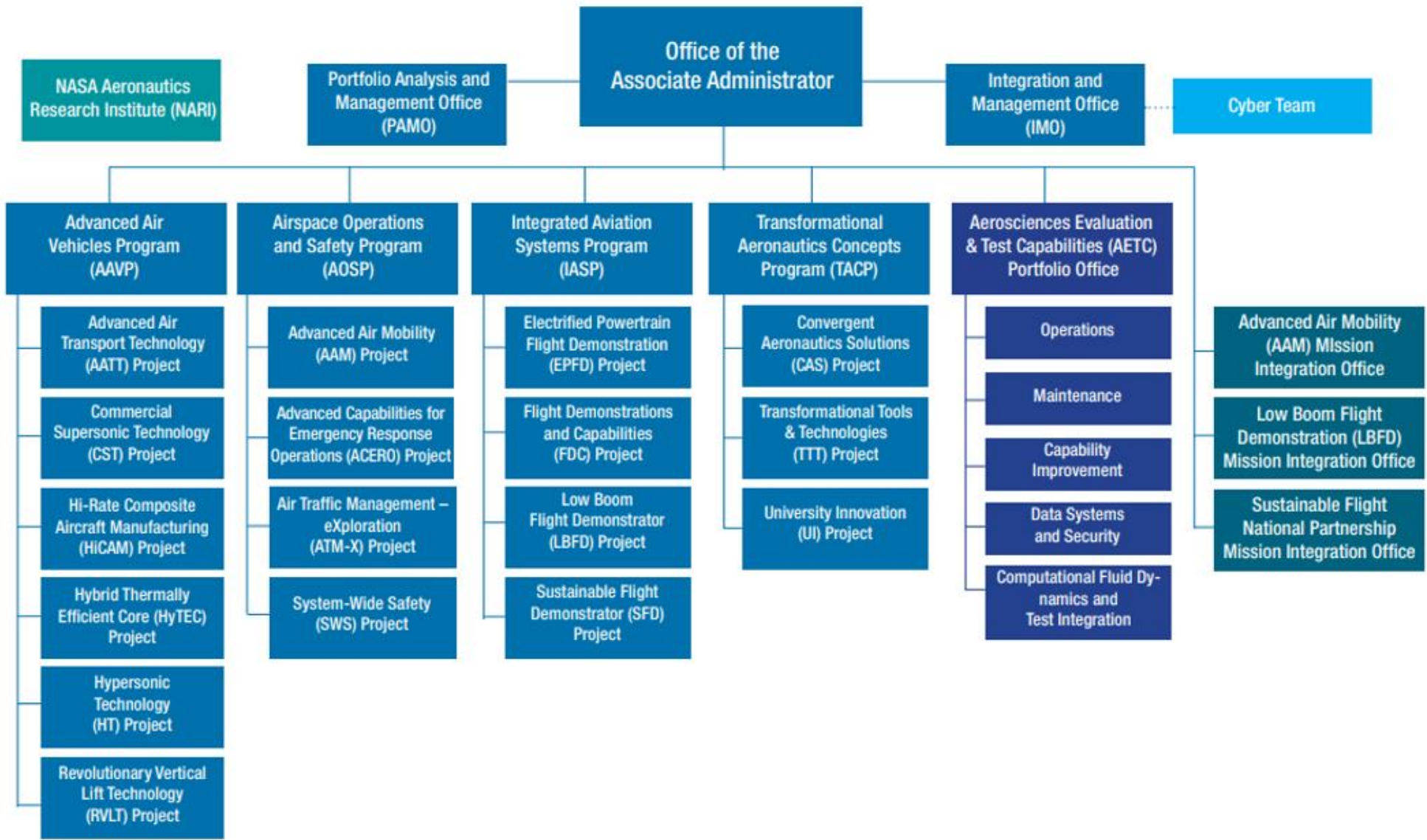




NASA Advanced Air Mobility Project (AAM)
SAE AeroTech Advanced Air Mobility R&D Plenary
March 15, 2023
Starr Ginn AAM Lead Strategist



ARMD Organization





AAM Project Organization

**Airspace Operations and Safety
Program (AOSP)**

**Advanced Air Mobility (AAM)
Project Office**

AAM Project Manager (PM): Karen Cate (Acting)
Deputy PM: Al Capps (Acting)
Deputy PM for Technology: Ken Goodrich
Chief Engineer: Colin Theodore
Lead Strategist: Starr Ginn
Lead Systems Engineer: Marian Cronin
Chief Safety and Mission Assurance: Cheng Moua

Assoc. PM for
AFRC
Cheng Moua

Assoc. PM for
ARC
Paul Borchers

Assoc. PM for
LaRC
Steve Alperin

*** PP&C Office**

Project PPC Lead: Nguyen Trang
Risk and Change Manager: Luis Mederos
Risk Management SME: Alonzo Bradford
Partnership Coordinator: Jamie Turner
PAO/Communication Lead: Teresa Whiting
Scheduler/Project Analyst: Irma Ruiz
AMIO Schedule Support: Trisha Stoebling
Business Analyst: Dianna Garcia
Business Analyst: Victoriana Delossantos
Lead Resource Analyst, GRC: Julie Blackett
Resource Analyst, AFRC: Karen Green
Resource Analysts, ARC: Tiana Vo
Resource Analyst, LaRC: Tracey Frisby

National Campaign Subproject

NC Lead: Divya Bhadoria (Acting)
Subproject Chief Engineer: Jeff Leigh
Tech Leads

**Automated Flight and Contingency
Management**

Subproject Manager: Patricia (Trish) Glaab
Tech Lead: Mike Feary

High Density Vertiplex

Subproject Manager (Acting): Jeff Homola
Tech Lead: Lou Glaab



AFCM Technical Work and Schedule Packages



TC: Automated Flight and Contingency Management

FOR EFFORTS THROUGH FY25

Develop and evaluate an initial, integrated set of key vehicle functions for automation enabled piloting in urban operations, and propose recommendations to support requirements for certification and approvals for the selected concepts

AFCM SCHEDULE PACKAGE CONTRIBUTIONS

Aircraft Handling and Operations (AHO)

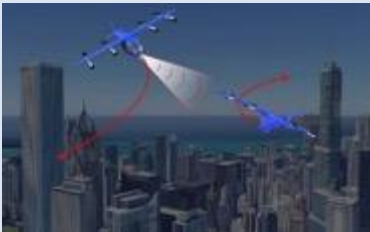


Integrated Piloting Requirements (IPR)



Automation Enabled Pilot (AEP) TWP

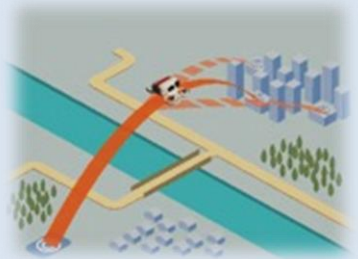
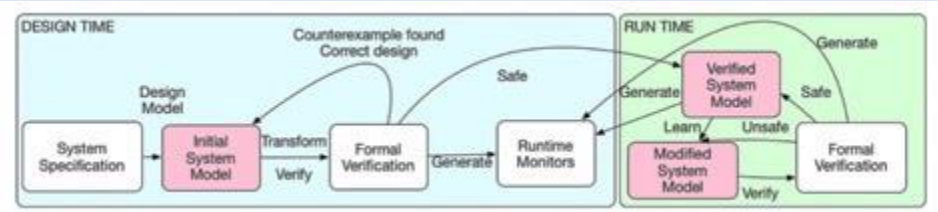
Hazard Perception and Avoidance (HPA)



Assured Vehicle Automation (AVA) TWP

Flight Path Management (FPM):

Assured Responsible Automation (ARA):

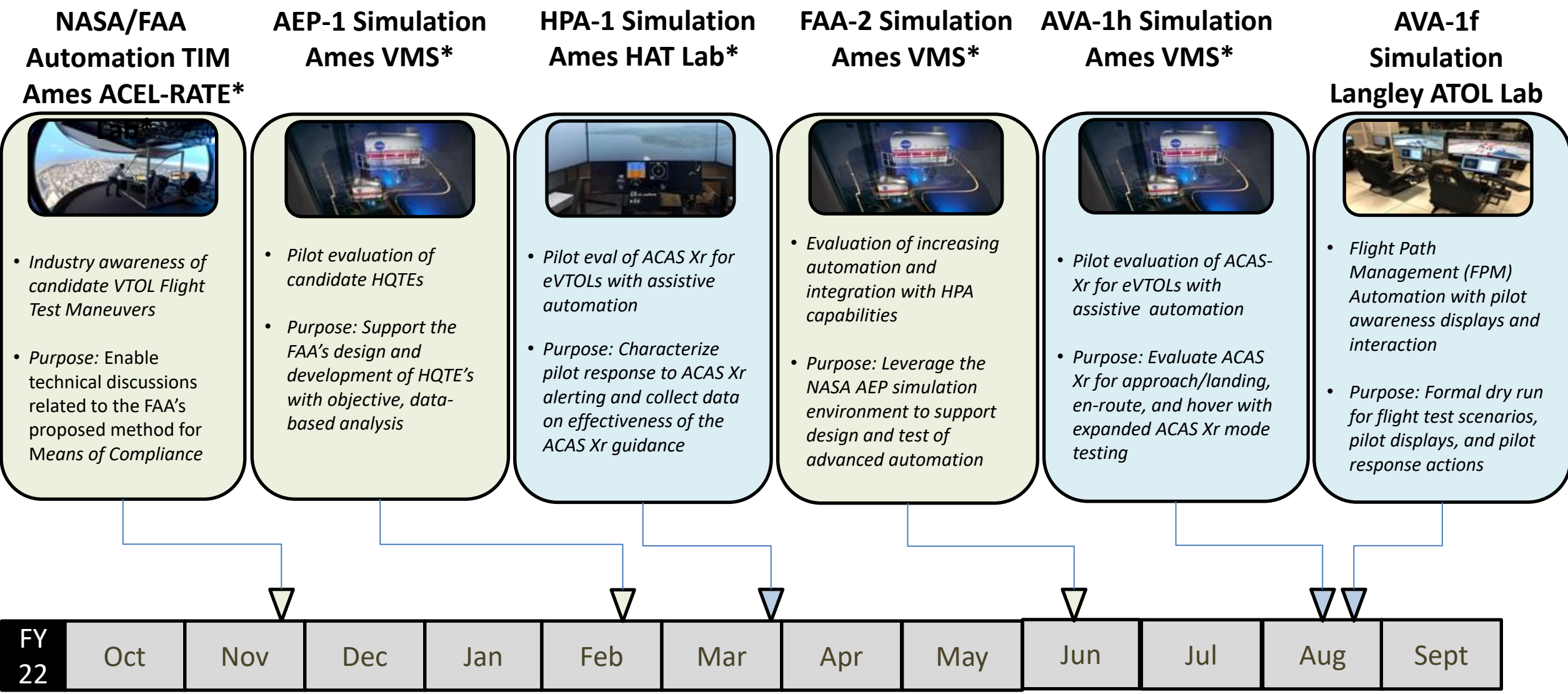


Integrated Automation Suite (cross-schedule packages FPM-HPA-IPR):

Integrated reference framework and evaluation tools for cooperative conflict management and mission management in UAM CONOPS.



AFCM FY22 Testing Accomplishments



* Government and industry participants

Assured Vehicle Automation (AVA)

Automation Enabled Pilots (AEP)



AFCM FY22 Research Publications and Reporting

Formal Publications

Deliver research findings to the aviation community

Customer: NASA, Industry, FAA

- DASC 2022 Conference Paper (Best in Session Award): “Initial Performance Evaluation of Flight Path Management Onboard Automation”, Barney and Barrows, (FPM)
- NASA/TM-20220009974: “Flight Path Management Automation Concept for Advanced Air Mobility”, Sharma and Wing, (FPM)

Regulatory Contributions

Directly contribute to evolving regulations, standards, and compliance development

Customer: Standards Development Organizations (SDO)

- WK76067 WG (Lead): Indirect Flight Controls standards development, Feary (IPR)
- WG4 (Author): UAS Navigation Gap Analysis , Digital Flight section, Wing (FPM)
- VFS eVTOL Flight Test Council, HMI Committee (Participant), Feary (IPR)

In Collaboration with System Wide Safety (SWS):

- ASTM F44.50 WK 60748 (Co-author): “Standard Guide for the Application of STPA to Aircraft”, Neogi (ARA)
- SAE ARP 4761A (Reviewer): "Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems", Graydon and Neogi
- SAE G-34 (Contributor): “Artificial Intelligence (AI) in Aviation” , Goodloe (ARA)
- UL 4600 (Contributor): “Safety Analysis for Autonomous Systems”, Graydon (ARA)



AFCM SDO Participation

HPA

- [RTCA SC-147](#): Traffic Alert & Collision Avoidance System (TCAS)
- [RTCA SC-228](#): Minimum Performance Standards for Unmanned Aircraft Systems

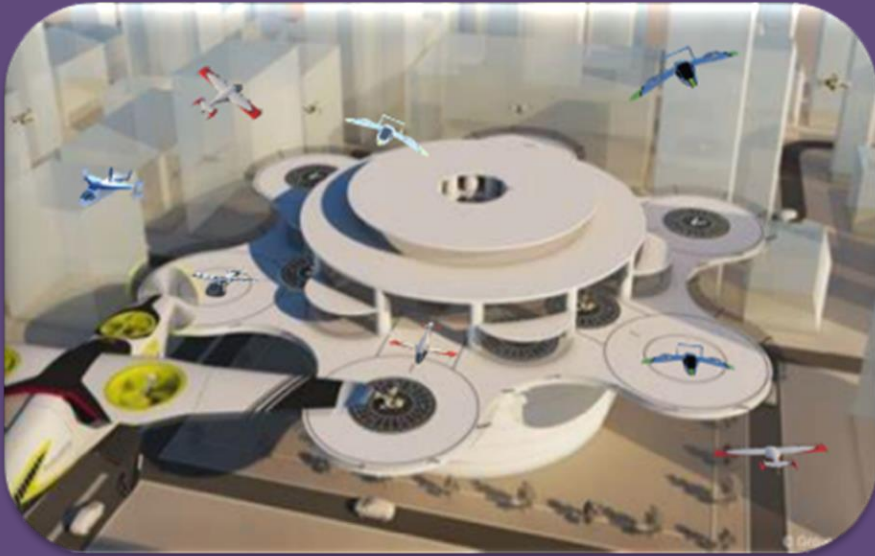
IPR/AHO

- [ASTM F44. 20 WK76067](#) (Feary Leading): Handling Quality Evaluation for Aircraft with Indirect Flight Controls

FPM – Outreach to establish WG or SC for FPM governance, ConOps synergies

- [ASTM AC 377 F38](#): Autonomy in Design and Operations in Aviation

High Density Vertiplex



Technical Challenge

Develop and evaluate a reference automation architecture that addresses scalable and efficient aircraft operations, flight and airspace management procedures, and vertiport operations in high density vertiplex environments.

Schedule Package Goals:

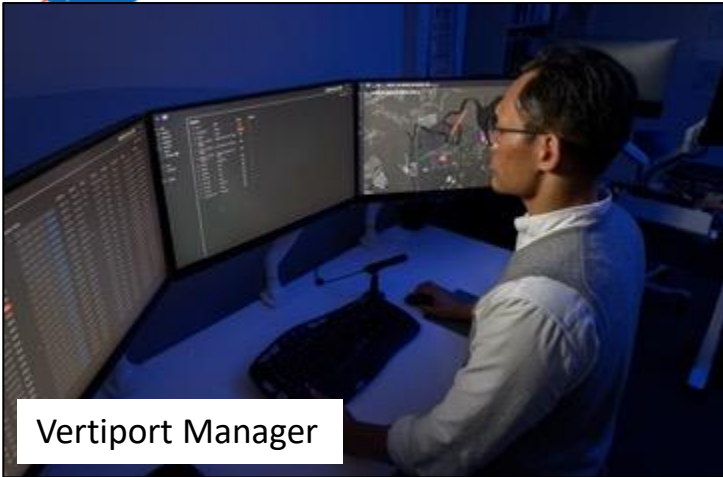
- **Advanced Onboard Automation (AOA)**: Develop reference automation architecture prototypes, integration guidelines, and safety risk assessments that support increasingly autonomous and resilient operations.
- **Scalable Autonomous Operations (SAO)**: Develop and evaluate concepts, prototypes, procedures and technologies supporting operations at increased scale from a vertiport.
- **Vertiplex Operations (VO)**: Develop and evaluate concepts, procedures and technologies to evaluate system prototypes supporting high density operations in and out of multiple nearby vertiports.
- **Integration of Automated Systems 2 – HDV (IAS-2.HDV)**: Develop and evaluate vertiport automation reference architecture for a representative UAM aircraft in a vertiplex environment.



AOA Integrated Architecture Elements

ARC

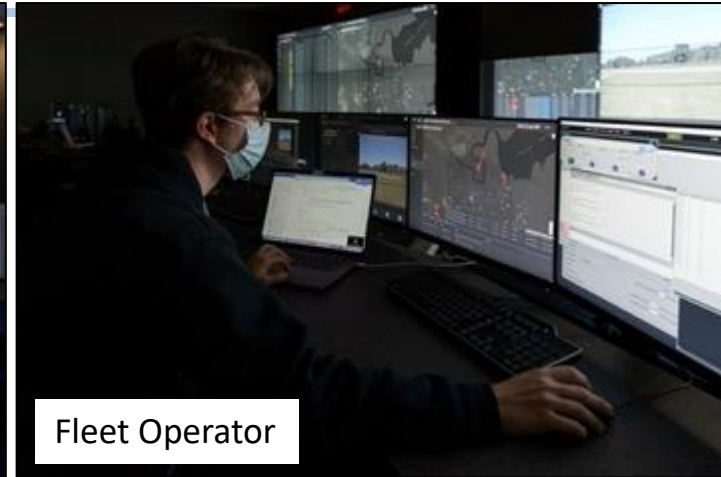
LaRC



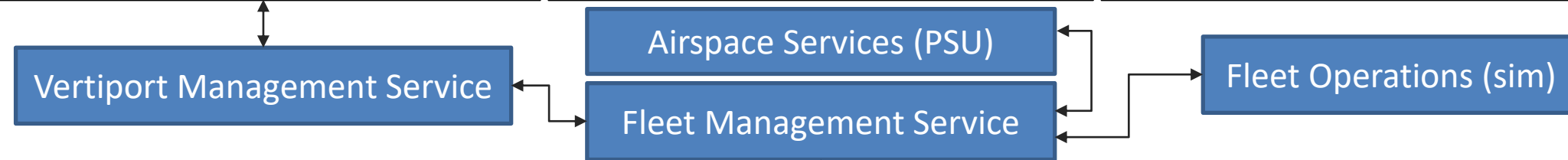
Vertiport Manager



Fleet Manager



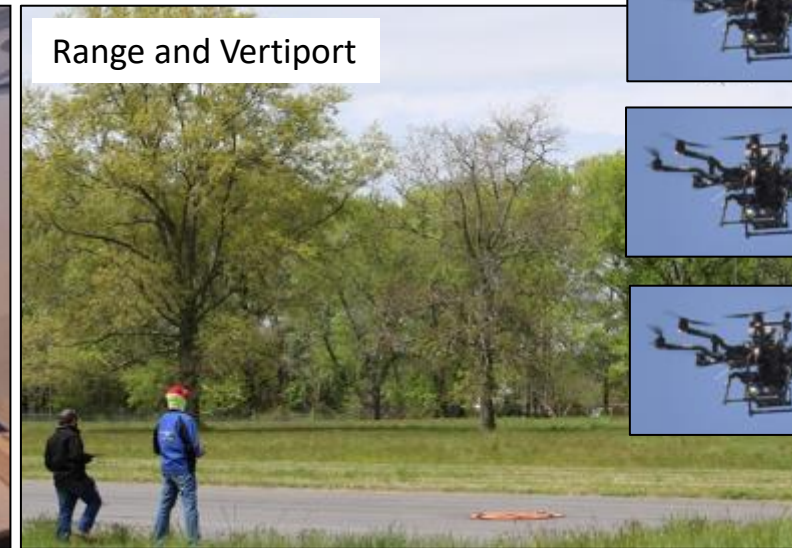
Fleet Operator



Range Operations and Flight Center



Flight Crew



Range and Vertiport



Vehicles and Onboard Automation

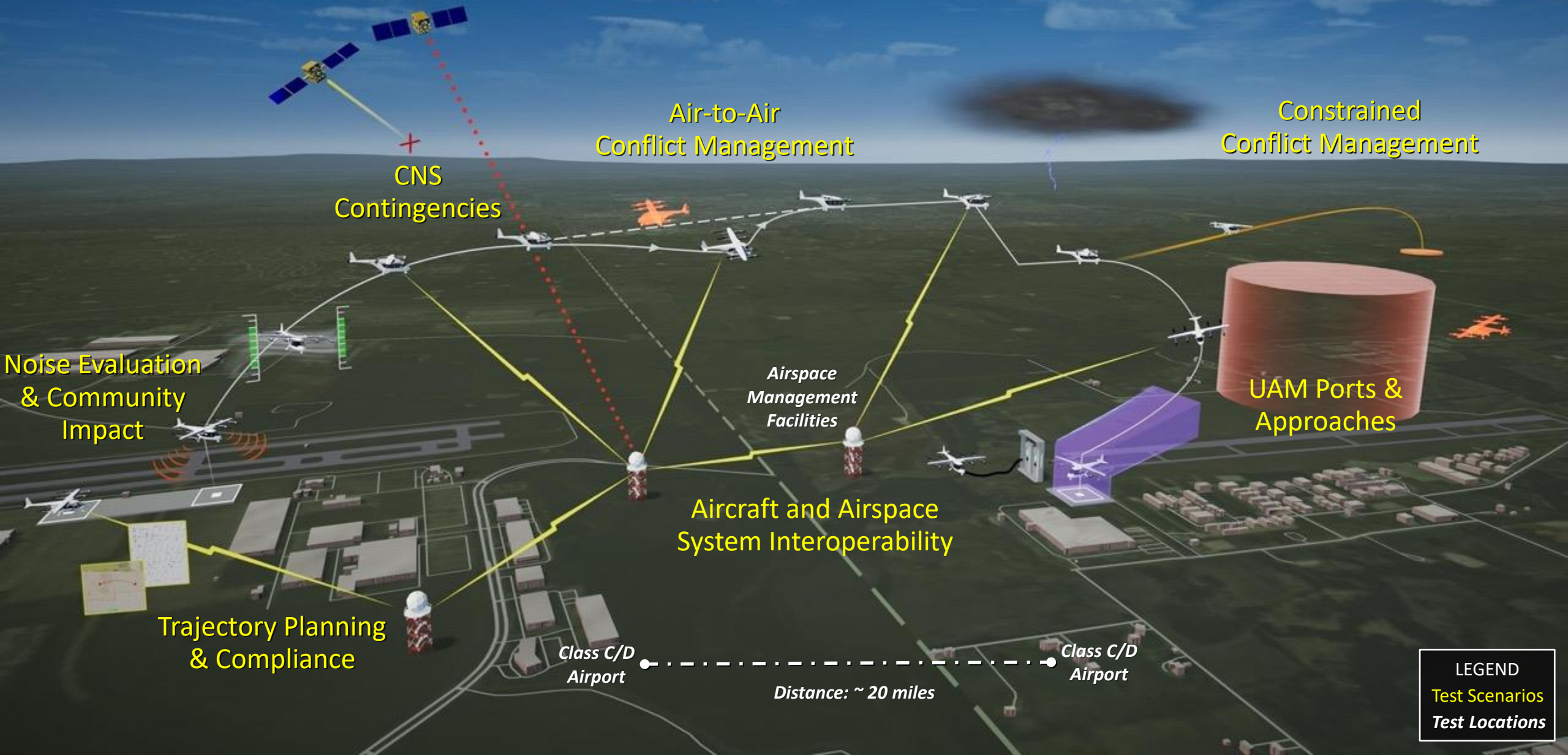


HDV AOA Information Dissemination

- Advanced Air Mobility (Aam) Vertiport Automation Trade Study:
<https://ntrs.nasa.gov/citations/20210009757>
- High-Density Automated Vertiport Concept Of Operations:
<https://ntrs.nasa.gov/citations/20210016168>
- Vertiport Automation Software Architecture And Requirements:
<https://ntrs.nasa.gov/citations/20210019083>
- DASC 2022 Publications:
 1. Glaab, L: *The High Density Vertiplex Advanced Onboard Automation Overview*
 2. Unverricht, J: *Eye Glance Behaviors of Ground Control Station Operators in a Simulated Urban Air Mobility Environment (TTT Collaboration)*
 3. Suzuki, A: *A Flight Replanning Tool for Terminal Area Urban Air Mobility Operations*
 4. Gaug, N: *Lightweight Surveillance and Target Acquisition Radar Characterization for High Density Vertiplex Beyond Visual Line of Sight Operations*
 5. Hodel, G: *Usability Evaluation of Fleet Management Interface for High Density Vertiplex Environments*
- AOA Flight Test report NASA TM (R. McSwain): *Final release stages*
- NASA Feature Content: <https://www.nasa.gov/feature/nasa-vertiport-research-takes-flight>
- ASTM Standards: F38 Committee member on Vertiport Design and Vertiport Automation to develop standards for vertiport service development and interoperability



NASA National Campaign OV-1



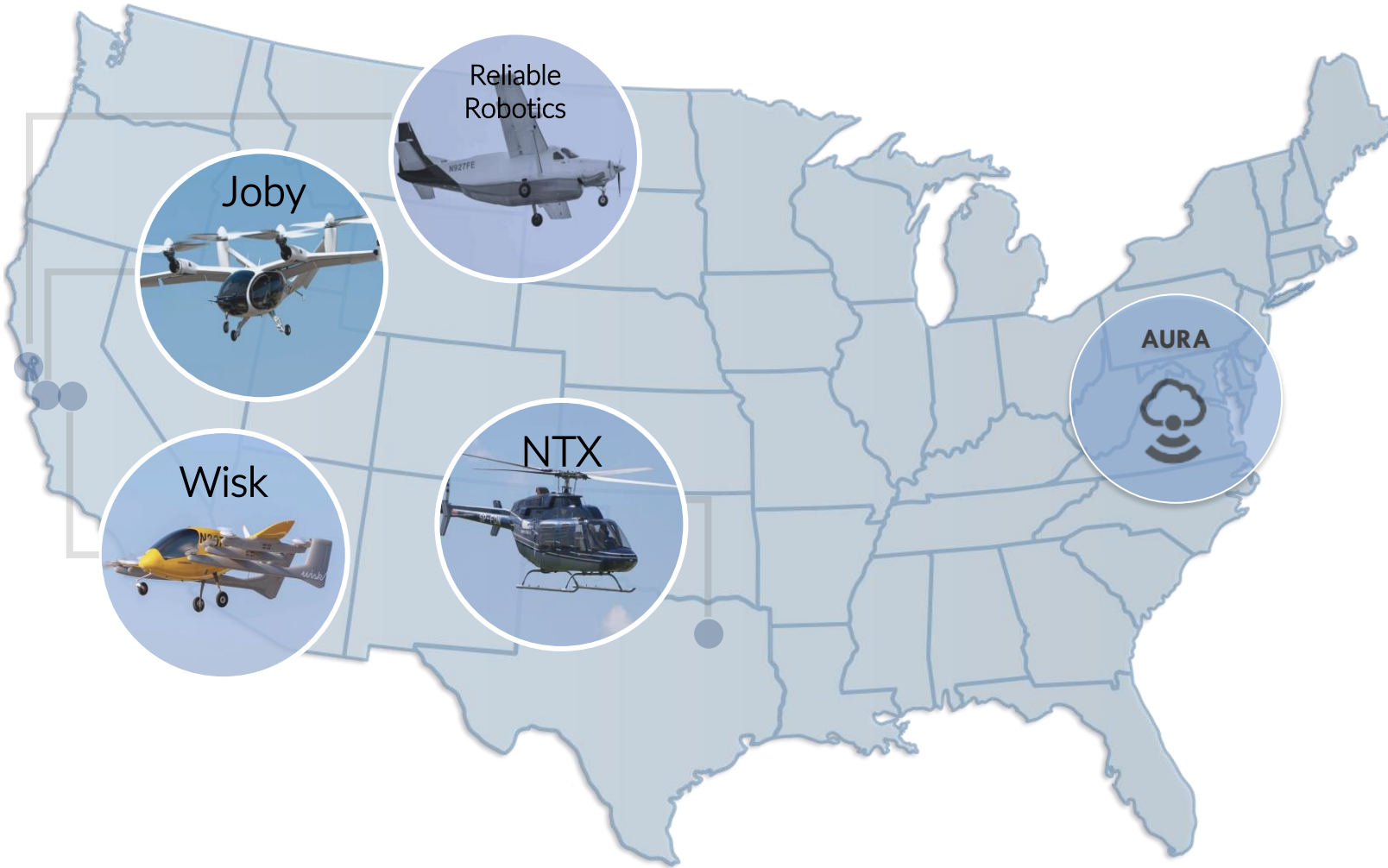
LEGEND

Test Scenarios

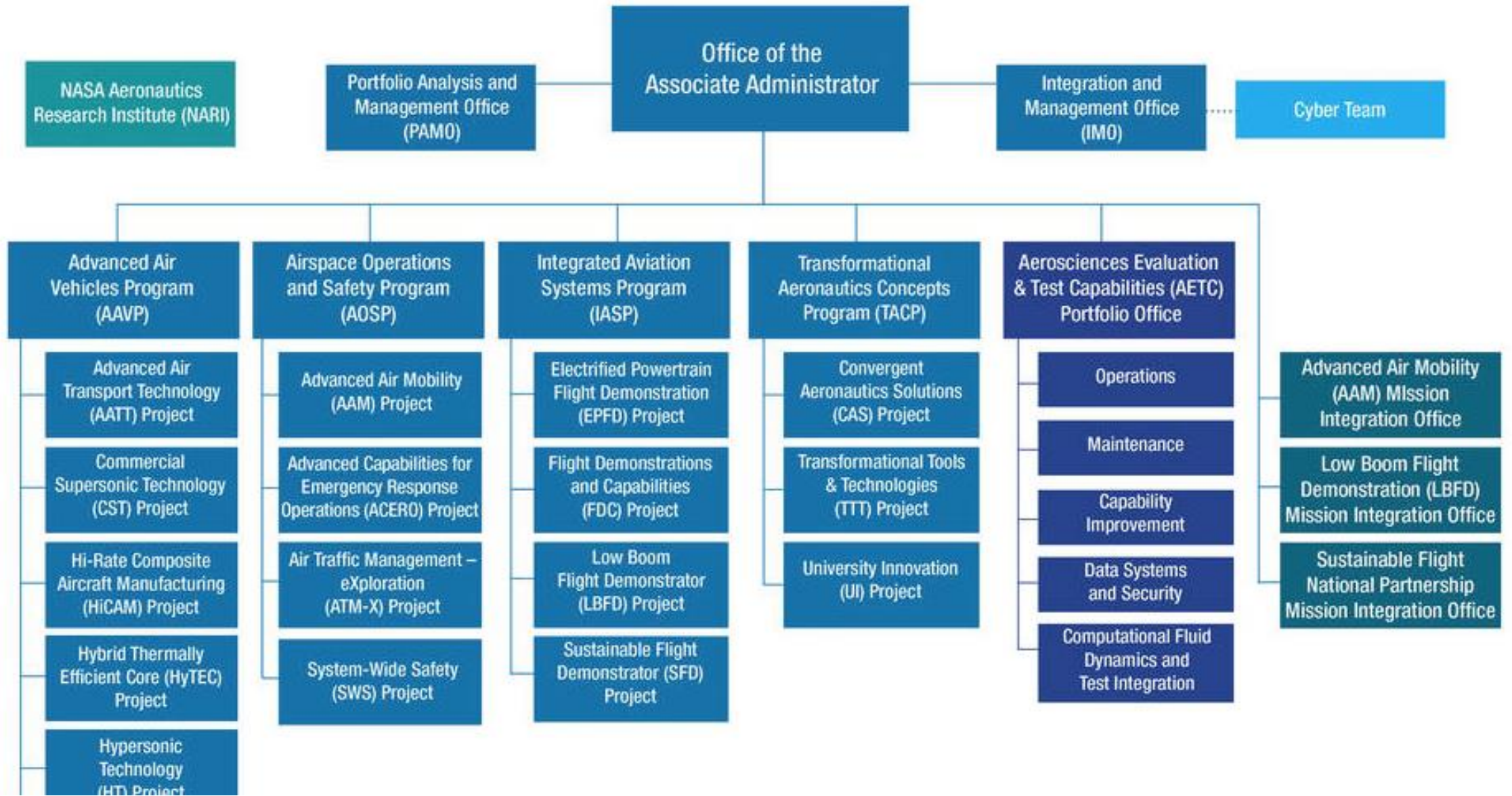
Test Locations



NC-1 Partner Objective Mapping



- 1 Accelerate Certification and Approval**
Will not be able to meet full success criteria through NC-1
- 2 Develop Flight Procedure Guidelines**
Joby Piloted - Urban Ops
- 3 Assess Infrastructure & CNS Trade Space**
Wisk Cohort - Automated Urban Ops
NTX Cohort - Urban Ops
Reliable Robotics - Regional Ops
AURA
- 4 Demonstrate an Airspace Management Architecture**
Wisk Cohort - Automated Urban Ops
NTX Cohort - Urban Ops
AURA
- 5 Identify Community Considerations**
Wisk Acoustics Test



X-57 Maxwell

Purpose:

Advance the Nation's ability to design, test, and determine airworthiness of distributed electric and aero-propulsive coupling technologies, which are a critical enabler of emerging, advanced air mobility markets.





Sampling of Ongoing External Requests to the X-57 project

As-built information on distributed electrical system weight, thermal, EMI, efficiency, and performance

X-57 data supporting electric / hybrid aircraft study to identify performance gaps for future S&T research

Reference data for means of compliance for demonstration of minimum flight speed with high-lift propellers

X-57 data supporting development of test facilities

X-57 motor and battery components as FAA moves towards performance-based rules in Part 33

USAF Agility Prime



FAA Tech Center



FAA Policy & Innovation



OUSD Research & Engineering

ASTM Committee F44 Standard F3179 & F3180



ASTM Committee F44 Standard F3173

ASTM Committee F44 Working Group WK66028

Reference data for means of compliance for demonstration of minimum control speed with distributed propulsion system

Vertical Flight Society
VFS eVTOL Flight Test Council



Simulation work in support of X-57 Mod IV flights, including piloted simulation exercises

X-57 personnel developing a Distributed Electric Propulsion standard at request of subcommittee

X-57 is providing essential information to a broad collection of government and industry groups



Electrified Powertrain Flight Demonstration



EPFD RASWG Expertise Works with SDOs and FAA Policy

NASA EPFD RASWG Areas of Expertise

- Electric Storage Systems/Batteries
- Distributed Propulsion Systems
- Electric Engines
- EMI Testing
- EMI, HIRF, Lightning, Single Event Upsets
- Endurance Tests for Aircraft Electric Engines
- FAR 33 & magniX special condition
- Electric Wiring Interconnect Systems
- Flight Systems
- Lightweight Connectors & Wiring
- Means and Methods of Compliance to Aircraft Regulations
- Bird strike
- Permanent-Magnet Propulsion Motors and Associated Variable-Speed Drives
- Power Quality
- Safety Considerations for EAP
- High Voltage Materials

NASA EPFD Engaged Standards Development Organizations (SDO)

ASTM

- ASTM F39 on Aircraft Systems
- ASTM F44 on General Aviation Aircraft
- ASTM D02, Petroleum Products and Lubricants
- ASTM D30, Composite Materials

SAE

- SAE AE-10 High Voltage Committee
- SAE E-40, Electrified Propulsion Committee
- SAE AE-2 Lightning Committee
- SAE AE-7 Aerospace Electrical Power and Equipment Committee
- SAE G-28 Simulants for Impact and Ingestion Testing

RTCA

- SC 135 Environmental Testing
- SC 225 Rechargeable Lithium Batteries and Battery Systems

FAA Certification Policy Engagement in SDOs

ASTM

- ASTM F39
- ASTM F44

SAE

- SAE AE-10
- SAE E-40

EPFD Regulations and Standards Works With FAA Certification Policy Through The Standards Development Process